Foreign Elites From the Oxus Civilization? A Craniometric Study of Anomalous Burials From Bronze Age Tepe Hissar

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KEY WORDS craniometry; phenetic distance; central Asia; Iran; elites

ABSTRACT Discovery of a small number of individuals in the Period III necropolis at the large northern Iranian Bronze Age site of Tepe Hissar directly associated with a complex of imported artifacts raises the question of whether these individuals represent elites who had access to these exotic commodities, or an imposed foreign elite that may have brought these unusual artifacts from their homelands. The source of the atypical objects is believed to be the Oxus civilization of central Asia. This study investigates the identity of these individuals by employing canonical discriminant function analysis of 20 craniometric variables among 174 adult males from Tepe Hissar Period III and Oxus civilization males from Sapalli tepe and Djarkutan. Dicriminant function analysis provides a strong separation between Tepe Hissar Period III males and Oxus civilization males and a high level of correct assignation by sample (95.8%). Imposition of the five males associated with imported central Asian artifacts from the Period III necropolis indicates that the majority (4/5) are phenetically indistinguishable from other Period III Tepe Hissar males. The results indicate that these individuals most likely represent local elite inhabitants of Tepe Hissar, rather than the presence of an imposed foreign elite. However, given the scarcity of crucial specimens, especially females, and comparative skeletal series, this conclusion must remain tentative. Am J Phys Anthropol 110:421–434, 1999.

During the course of excavating large necropoli, archaeologists occasionally encounter a small number of unique and exotic artifacts that stand in contrast to the majority of items recovered from the site. Such objects often feature different manufacturing techniques, raw materials, design, or ornamentation and apparently have no precedent, with either antecedent materials, or contemporaneous artifacts. When such exotic imported objects are found in direct association with human burials, the question immediately arises; do these individuals represent local inhabitants who had special access to exotic commodities (i.e., elites), or do these remains reflect the presence of foreign elites that may have brought these unusual artifacts with them from their homelands? This study employs statistical analyses of craniometric data from the northern Iranian Bronze Age site of Tepe Hissar to address this question, and the results obtained are cast in light of current archaeological theories of interactions among Bronze

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Age populations across the Indo-Iranian Borderlands during the Late Bronze Age.

Tepe Hissar represents one of the largest Bronze Age sites in northern Iran and is located southeast of the Caspian Sea on the Damghan Plain near the southern slopes of the Elurz Mountains (Fig. 1). Tepe Hissar was excavated under the direction of Erich Schmidt in the 1930s (Schmidt, 1933, 1937). Excavation of the large mound and surrounding environs resulted in the designation of six major areas of the site as: North Flat, Main Mound, Red Hill, Treasure Hill, Painted Pottery Flat, and South Hill. Three periods of Bronze Age occupation were defined by Schmidt and labeled Tepe Hissar Periods I, II, and III. Period III, dated between 3000 and 1631 BC (Kohl, 1992; Hiebert, 1994), represents the last and most extensive occupation. Remains from this period were found in all but one (Painted Pottery Flat) of the major regions of the site. Although Schmidt was convinced that the artifact assemblages indicated a smooth transition from Period II to Period III, two hoards on Treasure Hill [Hoard I, Hoard II (Schmidt, 1937)] associated with the third and final phase of Period III [phase IIIC: 2140–1631 BC (Hiebert, 1994), 2150–1885 BC (Dyson and Lawn, 1989; Hurst and Lawn, 1984)] featured a number of anomalous artifacts. These unprecedented artifacts included particular types of metal objects, semiprecious stone amulets, and miniature columns, disks, and vessels made from alabaster.

Excavation of the main mound revealed the presence of a large necropolis. Human interments were found scattered throughout an extensive area as various parts of the city fell into decay and were used as a repository for the dead. Excavation of burials from Period III led to additional discoveries of anomalous artifacts found in direct association with human burials as funerary items. By the time excavations ceased in 1932, 992 individuals from Tepe Hissar had been recovered. Of these, 609 could be attributed to the necropolis of Period III and a small minority (30/609; 5%) stood apart by possessing these unique artifacts as funerary items (Table 1).

Although Schmidt recognized that such artifacts were clearly anomalous and intrusive into the large corpus of material objects from Tepe Hissar, he was unsure of their most likely point of origin. He speculated that these items may signal the presence of foreign invaders (Schmidt, 1937) perhaps from Mesopotamia (or from the steppes of central Asia, see Krogman, 1940b). Nevertheless, Schmidt conceded that any stylistic similarities these anomalous objects shared with those recovered from the Royal Cemetery of Ur were tenuous, and may, in fact, derive from another, and as yet, unknown source (Schmidt, 1937).

Since the 1930s, further excavation of Bronze Age sites throughout the Indo-Iranian borderlands continued to turn up mysterious objects identical to those found by Schmidt at Tepe Hissar from such sites as Kurab (Stein, 1937), Khinaman (Curtis, 1988), Shahdad (Hakemi and Sajjadi, 1989), Quetta, and Mehrgarh VIII (Jarrige and Hassan, 1989). As at Tepe Hissar, these unique objects, although few in number, were consistently discovered clumped together and isolated from locally produced artifacts of a dramatically different cultural tradition. Such narrow and nucleated aggregation of unusual artifacts within a small minority of graves (approximately 5%) is more suggestive of possession by an elite segment of the population, rather than procurement by the general populace via long-distance trade contacts.

While analysis of these widespread but anomalous objects suggested some stylistic similarities with the known traditions of Mesopotamia to the west and the Indus Valley to the east, their point of origin remained elusive (Amiet, 1986, 1988; Sarianidi, 1981, 1985, 1987, 1994). Then, a series of excavations in the 1960s and 1970s by Soviet archaeologists revealed the existence of a previously unknown Bronze Age civilization focused on the oases of southern central Asia (Askarov, 1977, 1981; Askarov and Abdullaev, 1983; Hiebert, 1994; Kohl, 1981; Lamberg-Karlovsky, 1994a; Ligabue and Salvatori, 1988; Masson and Sarianidi, 1972; Sarianidi, 1981, 1994). Within the Margiana oasis of eastern Turkmenistan, and the northern, southern, and eastern Bactrian

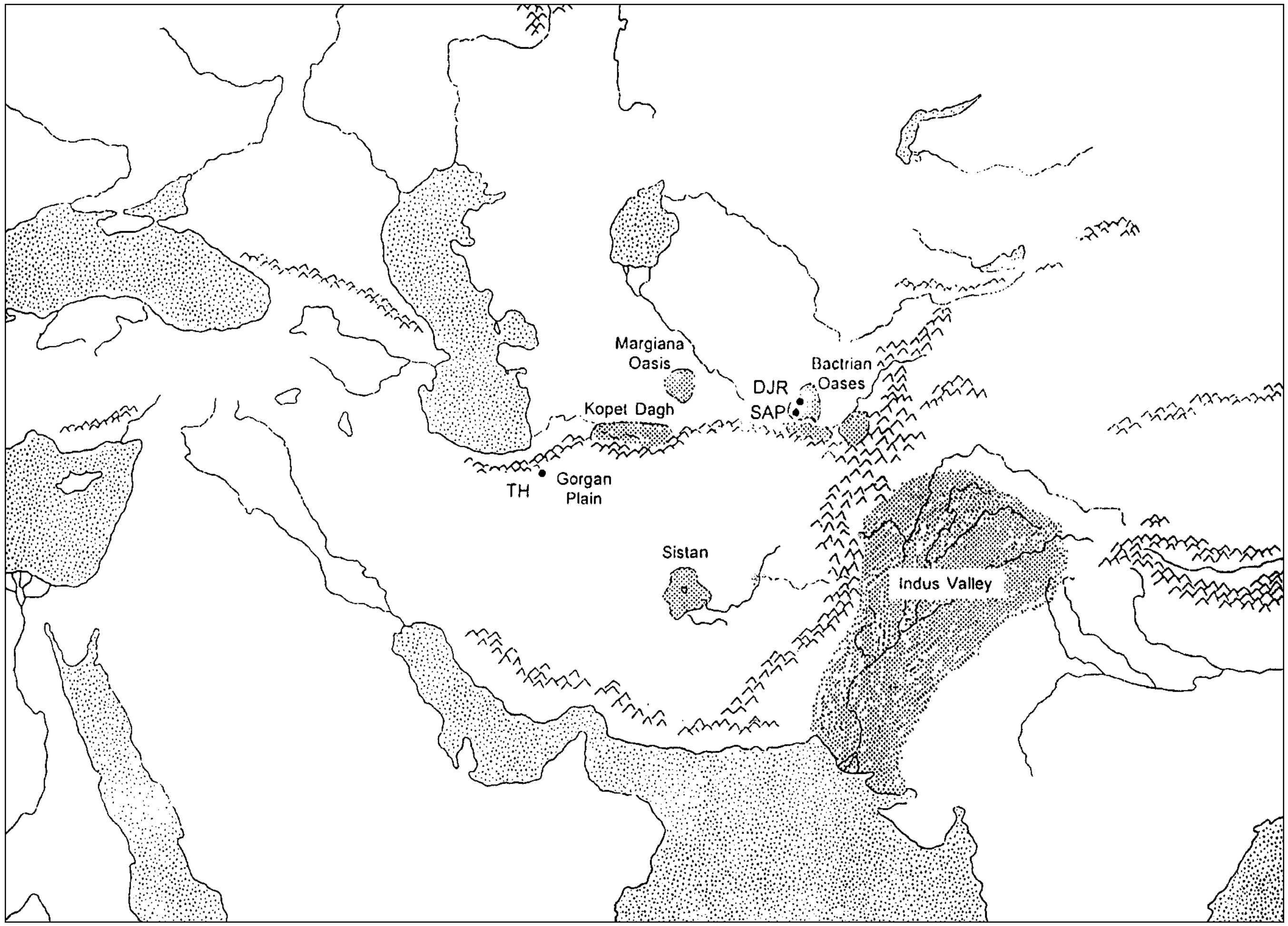

Fig. 1. Location of craniometric samples and important regions across the Indo-Iranian borderlands.

TABLE 1. Craniometric samples (males only)

Site	Date	Total individuals	Complete individuals[1]
Djarkutan (D)	2000–1500 B.C.	56	24
Sapalli tepe (S)	2200–2000 B.C.	17	9
Tepe Hissar III (T)	3000–1631 B.C.	102	85
	TOTAL	174	118

[1] Complete individuals are those for which all 20 measurements used in the discriminant function analysis were available.

oases of southern Uzbekistan and northern Afghanistan, urban centers were found that contained artifact assemblages dominated by these mysterious objects (Hiebert, 1994). The abundant frequencies of particular metal objects, semiprecious stone amulets, and miniature columns, disks, and vessels made of alabaster, coupled with a continuous sequence of prototypes for these artifacts among earlier [approximately 3500–2500 BC (Kohl, 1992)], closely affiliated sites in the Kopet Dagh foothill plain in central Turkmenistan, have convinced scholars that the most likely source for the anomalous objects at Tepe Hissar and other Indo-Iranian sites are the urban centers of the Oxus civilization found within the oases of Bactria and Margiana in southern central Asia (Hiebert, 1994; Hiebert and Lamberg-Karlovsky, 1992; Jarrige, 1994; Tosi, 1988).

Yet, while most scholars agree that the Oxus civilization represents the most likely source for the anomalous artifacts recovered from Tepe Hissar, there is considerable disagreement over the nature of interaction between the populations of this civilization and the Bronze Age inhabitants of neighboring regions. Noting the appearance of an entire complex of finished, characteristic Oxus civilization artifacts at Tepe Hissar and elsewhere, as well as the marked absence of finished Iranian and Baluchistani artifacts in Oxus civilization sites, several researchers believe this civilization represented a new, vigorous economic and cultural force that exercised hegemonistic power and influence upon Bronze Age urban centers throughout the Indo-Iranian borderlands during the last centuries of the second millennium BC and the first half of the first millennium BC (Hiebert, 1994; Hiebert and Lamberg-Karlovsky, 1992; Lamberg-Karlovsky, 1993, 1994b; Sarianidi, 1993, 1994). These scholars maintain that the appearance of an entire complex of unprecedented Oxus civilization artifacts in assemblages from neighboring regions provides evidence that the Oxus civilization expanded its influence throughout this vast region by establishing elite dominance over local populations in Iran and along the western periphery of the Indus Valley (Baluchistan).

A far different scenario of interactions across the Indo-Iranian borderlands during the Late Bronze Age is developed by Jarrige (1994) and Tosi (1988). They recognize that the Oxus civilization represented a new and powerful commercial force, but suggest no hegemonistic relationship existed between this civilization and the urban populations of neighboring regions. Rather, throughout the first half of the second millennium BC, the Indo-Iranian borderlands witnessed a general semi-homogenization of local cultures. Site assemblages throughout this region are marked by unique combinations of general Indo-Iranian influences in burial practices, symbolic objects, and other materials valued by a newly emerging elite, with objects that show a continuance of locally distinctive traditions. Jarrige and Tosi interpret these data as indicative of the participation of local elites, who shared a common socio-religious orientation and iconography, in a bidirectional exchange network with other elites throughout a vast area stretching from Elam in the west to the western border of the Indus Valley in the east, and from the oases of central Asia in the north to the Makran Coast in the south. The product of this bidirectional exchange was the formation of a *koiné*, or sphere of interaction (see also Amiet, 1988), in which no regional population held a position of hegemonistic dominance over the others.

The differential implications of these two views on the nature of interactions across the Indo-Iranian borderlands during the Late Bronze Age are clear. If the populations of the Oxus civilization represent a commercial force that held unilateral hegemonistic power over neighboring Bronze Age peoples,

and whose expansion was accomplished through establishment of elite dominance within neighboring urban centers, we expect the unprecedented appearance of characteristic Oxus civilization artifacts in neighboring urban centers to signal the presence of central Asian elites. It may be that possession of these artifacts provided a closely guarded material indicator of these individuals as representatives of this hegemonistic economic power. Hence, individuals recovered from neighboring regions, buried in direct association with characteristic Oxus civilization artifacts, such as those found by Schmidt in the Period III necropolis at Tepe Hissar, are likely to be these central Asian elites. If, however, the Oxus civilization held no such hegemonistic power over neighboring populations, the presence of central Asian artifacts may merely signal the participation of local elites in a bidirectional exchange of highly desired prestige commodities. Thus, individuals recovered from neighboring regions buried with Oxus civilization artifacts are expected to be local elites, not an imposed coterie of foreign elites.

TABLE 2. Anomalous Tepe Hissar III males with craniometric data

Specimen number	Abbr.	Grid location[1]	Burial number
33.16.162	A_1	DG-00	X-2
33.23.120	A_2	CG-90	X-1
33.23.124	A_3	DF-16	X-2
33.23.125	A_4	DF-16	X-9
33.23.126	A_5	DF-16	X-11
33.16.236	A_6	DF-19	X-2

[1] Grid locations and burial numbers are from Schmidt (1933, 1937).

MATERIALS AND METHODS

Materials

Although Schmidt (1933, 1937) reports that 609 individuals were recovered from the Period III necropolis at Tepe Hissar, the vast majority of these individuals are curated at the Ministry of Culture in Teheran and have never been studied. Fortunately, however, 162 Period III individuals were sent to the University Museum of the University of Pennsylvania. Of these 162 individuals, 138 adults (102 males, 36 females) are represented by cranial remains. Seven individuals encompassed by the collection of human remains at the University of Pennsylvania (6 males, 1 female) were found in direct association with anomalous artifacts (Table 2). Craniometric variation among members of the Tepe Hissar skeletal series were assessed by Krogman (1940a,b).

Human remains from Oxus civilization sites are numerous, but very few have been studied by physical anthropologists. Two notable exceptions are skeletal collections from the urban centers of Sapalli tepe and Djarkutan located in the north Bactrian oasis. These skeletal series provide the first physical anthropological data for the populations of this civilization (Hemphill, 1998, 1999; Hemphill et al., 1997, 1998).

The site of Sapalli tepe (Fig. 1) represents the most thoroughly documented Oxus civilization settlement in the north Bactrian oasis (Askarov, 1974, 1977). Excavation of the fortified area resulted in exposure of 125 single and 13 collective burials under house floors and walls. All human remains recovered from Sapalli tepe have been assigned to the Sapalli phase of the Oxus civilization (Askarov, 1977). A single radiocarbon date [2009 BC (Hiebert, 1994)] suggests a time span for the Sapalli phase between 2200 to 2000 BC. The Sapalli tepe sample encompasses 43 adult individuals with cranial remains (17 males, 26 females).

The site of Djarkutan is located approximately 40 km north of Sapalli tepe in the north Bactrian oasis. Excavations at this site led to the discovery of a large cemetery south of the habitation area (Askarov and Abdullaev, 1983; Askarov and Sirinov, 1991). Partial excavation of the cemetery resulted in recovery of 123 adult individuals (56 males, 67 females) with cranial remains. These individuals have been assigned to three later successive phases of the Oxus civilization (Djarkutan, Kuzali, Molali) and date to the period between 2000 and 1500 BC (Kohl, 1992; Hiebert, 1994). All craniometric measurements for Sapalli tepe and Djarkutan skeletal series were made by the author at the Institute of Archaeology, Uzbek Academy of Sciences, Samarkand, Uzbekistan.

TABLE 3. Craniometric variables used to generate discriminant functions

	Variable[1]
Neurocranium	
Maximum cranial length (GOL)	1
Maximum cranial breadth (BEB)	2
Basion-bregma height (BBH)	17
Biasterionic breadth (BASB)	12
Transverse biporial arc (TBPA)	24a
Frontal arc (FRA)	26
Parietal arc (PAA)	27
Occipital arc (OCA)	28
Horizontal circumference (CAB)	23b
Minimum frontal breadth (BFTB)	9
Facial skeleton	
Upper facial height (NPH)	48
Nasal height (NH)	55
Nasal breadth (NB)	54
Orbital height (OH)	52
Orbital breadth (OB)	51a
Bizygomatic breadth (BZB)	45
Internal palatal length (IPL)	62
Internal palatal breadth (IPB)	63
Basicranium	
Foramen magnum length (FML)	7
Foramen magnum breadth (FMB)	16

[1] Numbers of the variables as defined by Martin (1928).

Methods

Twenty cranial variables (ten for the neurocranium, eight for the facial skeleton, and two for the basicranium) of those defined by Martin (1928) were obtained for all samples and provide the metrical basis for the current study (Table 3). Because only one female from Tepe Hissar associated with anomalous artifacts is represented by cranial measurements, consideration is limited to contrasts among males. Tepe Hissar Period III males and central Asian males from Sapalli tepe and Djarkutan represented by cranial measurements number 174 adults. Since the Tepe Hissar series was measured by Krogman (1940a,b), while the central Asian series were measured by the author, a random sample of 52 Tepe Hissar crania were measured to provide an assessment of the degree of inter-observer agreement for craniometric measurements. The degree of inter-observer agreement was evaluated by repeated measures analysis of variance. Variables found unaffected by significant inter-observer error were tested for univariate significant differences across all three samples and between Tepe Hissar and central Asians (Sapalli tepe and Djarkutan samples pooled) with analysis of variance and Student's *t*-tests, respectively. Following the recommendations of Manly (1986), sample variables were tested for adherence to normal distributions with stem-and-leaf displays (Tukey, 1977; Velleman and Hoaglin, 1981) and for homogeneity of variance with Bartlett's (1947) chi-square (χ^2_B).

Data were then submitted to canonical discriminant function analysis. Individuals represented by incomplete data sets were eliminated from further consideration. Canonical discriminant axes were tested for significance by means of Wilks' λ, and canonical scores for each individual were plotted according to the first two discriminant axes to provide a visual assessment of the degree of separation between samples. Verification of correct group assignation was determined by discriminant function analysis. However, since it is well known that assignations from discriminant functions tend to be too optimistic, a bootstrap examination was conducted to provide a check on the accuracy of individual classifications. Two procedures, a traditional bootstrap procedure, known to be overly pessimistic, and Efron's (1983) 0.632 estimator, considered the most accurate method, were employed. Once all assignations were checked by bootstrap analysis, Tepe Hissar Period III males associated with anomalous artifacts and represented by a complete set of craniometric data were imposed upon the array provided by canonical discriminant function analysis. Group assignations were assessed to determine whether these individuals share closest phenetic affinities to central Asians from Sapalli tepe and Djarkutan or to other Tepe Hissar Period III individuals.

RESULTS

A comparison of measurements made by Krogman (1940a,b) and by the author of 52 randomly selected Tepe Hissar crania by means of repeated measures analysis of variance (Table 4) reveals no significant differences between observers. Therefore, contrasts of cranial measurements taken by the author from the two central Asian skeletal series (Sapalli tepe, Djarkutan) with those taken by Krogman from Tepe Hissar

TABLE 4. Repeated measures analysis of variance of Tepe Hissar crania

Variable	N	F	p	Variable	N	F	p
GOL	52	0.165	0.686	NPH	48	0.076	0.783
BEB	52	0.060	0.807	NH	50	0.038	0.846
BBH	48	0.001	0.970	NB	48	0.013	0.910
BASB	52	0.043	0.836	OH	51	0.970	0.327
TBPA	52	0.747	0.390	OB	50	0.124	0.726
FRA	52	0.199	0.656	BZB	33	0.094	0.760
PAA	50	0.674	0.414	IPL	44	0.059	0.809
OCA	50	0.180	0.673	IPB	41	0.023	0.881
HOR	52	0.406	0.525	FML	48	1.066	0.304
BFTB	52	0.555	0.458	FMB	46	0.725	0.397

Period III males may be made without being compromised by inter-observer differences.

Basic craniometric statistics for males of all three skeletal series are provided in Table 5. Univariate comparisons across all three samples by means of analysis of variance reveals that nine of 20 variables (45%) exhibit significant differences. Two variables are significant at the 0.05 level, while seven differ significantly at the 0.01 level. A contrast between central Asian (Sapalli tepe, and Djarkutan pooled) and Tepe Hissar Period III males with Student's t-tests yields eight significant differences (40%). Two are significant at the 0.05 level, while six differ significantly at the 0.01 level. Pooling of Sapalli tepe and Djarkutan males results in maximum cranial length (GOL) and orbital height (OH) failing to exhibit a significant difference when contrasted with Tepe Hissar Period III males, but does result in a significant difference for maximum cranial breadth (BEB).

Examination of stem-and-leaf displays indicates that none of these variables are marked by a significant departure from normal distributions in any of the three skeletal series. Results of an analysis of heterogeneity of group variances with Bartlett's (1947) χ^2 is provided in Table 6. Comparisons across all three samples indicate that two variables, orbital height (OH) and foramen magnum breadth (FMB), exhibit significant departures from homogeneity. Standard deviations provided in Table 5 suggest that in both cases this departure is due to markedly lower variance in the small sample from Sapalli tepe. Tests of heterogeneity of variance between central Asian males (Sapalli tepe and Djarkutan pooled) and Tepe Hissar Period III males yield only one significant difference [biasterionic breadth (BASB)]. Together, these results indicate that variation of the 20 craniometric variables within all three skeletal series manifest the normal distributions and homogeneity of variance required for canonical discriminant function analysis.

Data from Sapalli tepe, Djarkutan, and Tepe Hissar Period III males submitted to canonical discriminant function analysis resulted in elimination of 56 individuals with incomplete data sets (Table 1). Two canonical axes are produced by the contrast across all three samples and the separation of these samples is highly significant (Wilks' $\lambda = 0.255$; $F = 4.709$, $p = 0.000$). Canonical loadings for function one (Fig. 2) indicate that separation of samples occurs largely between those characterized by broad biasterionic and bizygomatic breadths from those characterized by long maximum cranial lengths, parietal arcs, internal palatal lengths, foramen magnum lengths, and by broad minimum frontal breadths, nasal breadths, palatal breadths, and foramen magnum breadths. The second function draws a distinction between generally large crania from crania marked by tall eye orbits. An examination of residual roots indicates that while the first function is highly significant ($\chi^2 = 144.238$, $p = 0.000$), the second function is not ($\chi^2 = 20.554$, $p = 0.360$).

Results from the canonical discriminant function contrast between central Asian males (Sapalli tepe and Djarkutan pooled) and Tepe Hissar Period III males yields a single canonical axis. The separation of samples provided by this axis is highly significant (Wilks' $\lambda = 0.320$, $F = 10.285$, $p = 0.000$). Canonical loadings along this axis (Fig. 2) indicate that separation of samples is largely between those characterized by long frontal arcs, broad cranial breadths (BEB, BASB), and tall eye orbits, from those characterized by long palates and long transverse biporial arcs.

Ordination of individual canonical scores for the first two canonical axes across all three samples is provided in Figure 3. This figure reveals a strong separation between Tepe Hissar Period III males in the right half of the array from Sapalli tepe and

TABLE 5. Basic craniometric statistics for samples used in the study

Variable	Djarkutan *N*	Djarkutan Mean[1]	Djarkutan SD	Sapalli tepe N	Sapalli tepe Mean	Sapalli tepe SD	Tepe Hissar III N	Tepe Hissar III Mean	Tepe Hissar III SD
GOL	49	188.2	6.2	15	183.7	8.4	96	188.1	6.1
BEB	31	136.5	5.8	13	134.3	5.0	95	133.9	5.1
BBH	44	138.1	5.9	11	131.3	3.3	87	134.7	5.3
BASB	31	107.8	5.7	9	107.8	4.0	87	102.4	4.1
TBPA	34	308.6	12.9	11	299.6	8.4	94	306.5	10.9
FRA	49	130.2	7.3	16	127.4	7.5	96	128.2	6.3
PAA	45	131.3	6.9	15	125.7	9.1	96	132.8	7.0
OCA	41	120.1	8.0	10	117.8	11.0	93	118.0	7.1
HOR	33	516.6	18.4	11	508.9	15.1	95	514.8	14.6
BFTB	45	94.7	4.0	11	93.0	4.1	96	95.4	4.3
NPH	49	70.2	4.9	14	69.3	4.5	94	69.8	5.3
NH	50	51.1	2.9	14	51.1	3.1	93	50.5	3.4
NB	43	25.3	1.9	13	24.4	1.8	91	25.4	1.9
OH	48	31.3	2.2	14	32.6	1.2	94	32.0	1.9
OB	48	38.7	2.2	13	37.6	2.4	93	41.2	2.8
BZB	30	130.9	5.1	10	127.5	5.3	91	127.0	5.6
IPL	40	44.7	2.9	11	42.9	2.2	89	47.5	3.1
IPB	41	39.7	2.6	10	37.7	4.3	88	40.0	3.0
FML	45	34.3	2.6	10	33.4	2.6	87	36.1	2.4
FMB	41	28.9	2.3	9	28.6	0.8	87	29.5	1.8

[1] Mean values and standard deviations are in centimeters.

TABLE 6. Univariate contrasts across samples

Var.	All three samples *F*	*p*	χ^2_B	*p*	*N*	Central Asians vs. Tepe Hissar III *t*	*p*	χ^2_B	*p*
GOL	3.268	0.041	3.092	0.213	160	0.979	0.329	1.283	0.257
BEB	2.921	0.057	0.743	0.690	139	2.036	0.044	0.459	0.498
BBH	9.377	0.000	4.202	0.122	142	2.095	0.038	1.316	0.251
BASB	19.711	0.000	5.639	0.060	127	6.304	0.000	4.070	0.044
TBPA	2.603	0.078	2.957	0.228	139	0.039	0.969	1.125	0.289
FRA	1.776	0.173	1.705	0.426	161	1.220	0.224	1.845	0.174
PAA	6.397	0.002	2.044	0.360	156	2.406	0.017	0.830	0.362
OCA	1.116	0.330	3.983	0.136	144	1.232	0.220	2.337	0.126
HOR	1.005	0.369	2.669	0.263	139	0.039	0.969	2.341	0.126
BFTB	1.754	0.177	0.282	0.868	152	1.427	0.156	0.244	0.622
NPH	0.233	0.792	0.885	0.643	157	0.332	0.740	0.827	0.363
NH	0.721	0.488	1.471	0.479	157	1.202	0.231	1.618	0.203
NB	1.567	0.212	0.096	0.953	147	1.029	0.305	0.006	0.941
OH	3.081	0.049	6.245	0.044	156	1.206	0.230	0.724	0.395
OB	21.630	0.000	3.547	0.170	154	6.418	0.000	3.142	0.076
BZB	6.031	0.003	0.362	0.834	131	3.004	0.003	0.159	0.690
IPL	19.769	0.000	1.749	0.417	140	5.963	0.000	0.373	0.541
IPB	2.621	0.076	4.399	0.111	139	1.299	0.196	0.054	0.816
FML	11.493	0.000	0.688	0.709	142	4.670	0.000	0.708	0.400
FMB	1.674	0.191	9.718	0.008	137	1.768	0.079	1.102	0.294

Djarkutan males on the left. The second axis shows no separation between central Asian males and Tepe Hissar Period III males, but does provide a small degree of separation between Djarkutan males, located in the upper left of this array, from Sapalli tepe males which occupy the lower left quadrant.

The frequency of correct assignation of individuals by canonical discriminant function analysis across all three skeletal series is provided in Table 7. Overall, 107 of 118 males (90.7%) are correctly assigned by series. Highest correct assignations occur for Tepe Hissar Period III males (81/85 = 95.3%), followed by Djarkutan males (19/24 = 79.2%). Correct assignations are lowest for Sapalli tepe males (7/9 = 77.8%). Frequencies of correct assignations are even greater when comparison is limited to central Asian males versus Tepe Hissar Period III males (Table 8). Overall, 113 of 118 individuals (95.8%) are correctly classified by region. Of the five males misclassified by this contrast, four are Tepe Hissar Period III males mis-

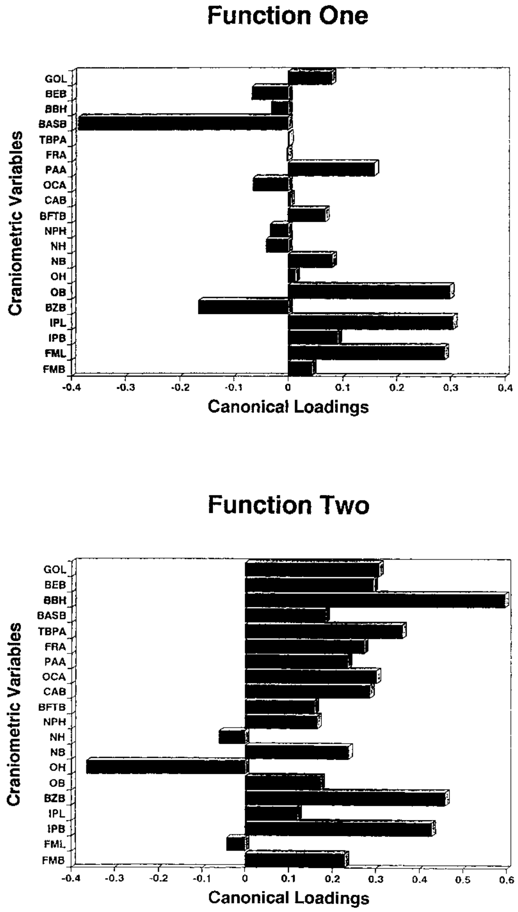

Fig. 2. Discriminant function loadings for contrast across all three samples.

identified as central Asian males, while only one central Asian male is misidentified as a Tepe Hissar Period III male.

A traditional bootstrap examination also yields high levels of correct assignations, regardless of whether the contrast is drawn across all three skeletal series, or between central Asian males and Tepe Hissar Period III males (Table 9). When all three samples are compared, the overly pessimistic traditional bootstrap method indicates that only 78.7% of individuals are correctly assigned by skeletal series, while 88.6% of individuals are correctly assigned when the contrast is limited to central Asian males and Tepe Hissar Period III males. Somewhat better results are obtained with the more highly regarded 0.632 estimator method (Efron, 1983). This method indicates that 83.1% of individuals are correctly assigned across all three samples, and 91.3% of individuals are correctly assigned when the contrast is between central Asian males and Tepe Hissar Period III males. Taken together, these results indicate that canonical discriminant function analysis provides a strong separation between males of these three Bronze Age skeletal series.

When individual canonical scores are calculated for the Tepe Hissar Period III males found directly associated with anomalous grave goods, one individual (A_6) is eliminated due to an incomplete set of measurements. Scores for the remaining five were imposed on the array of individual canonical scores across all three samples (Fig. 4). The individual canonical scores for all but one of these five individuals fall well within the distribution of other Tepe Hissar Period III males. The sole exception (A_5) occupies a position near the center of the phenetic space occupied by Djarkutan males.

DISCUSSION

The results indicate that canonical discriminant function analysis provides a strong separation of males from Sapalli tepe, Djarkutan, and Tepe Hissar Period III. Since all samples derive from Bronze Age sedentary agricultural populations differing little in latitude, it is unlikely that changes in masticatory stresses (Carlson and Van Gerven, 1977; Van Gerven, 1982) or natural selection for adaptation to markedly different environmental conditions (Beals, 1972; Guglielmino-Matessi et al., 1979) are responsible for the craniometric differences among central Asian males and Tepe Hissar Period III males. Since repeated measures analysis of variance fail to identify any significant interobserver differences between Krogman and the author, it is likely that the strong phenetic separation between central Asian and Tepe Hissar Period III males reflects, at least to some degree, the genetic isolation of these two Late Bronze Age gene pools (Devor, 1987; Howells, 1966; Nakata et al., 1974; Susanne, 1975, 1977).

Identification of phenetic affinities possessed by Tepe Hissar Period III males directly associated with anomalous artifacts

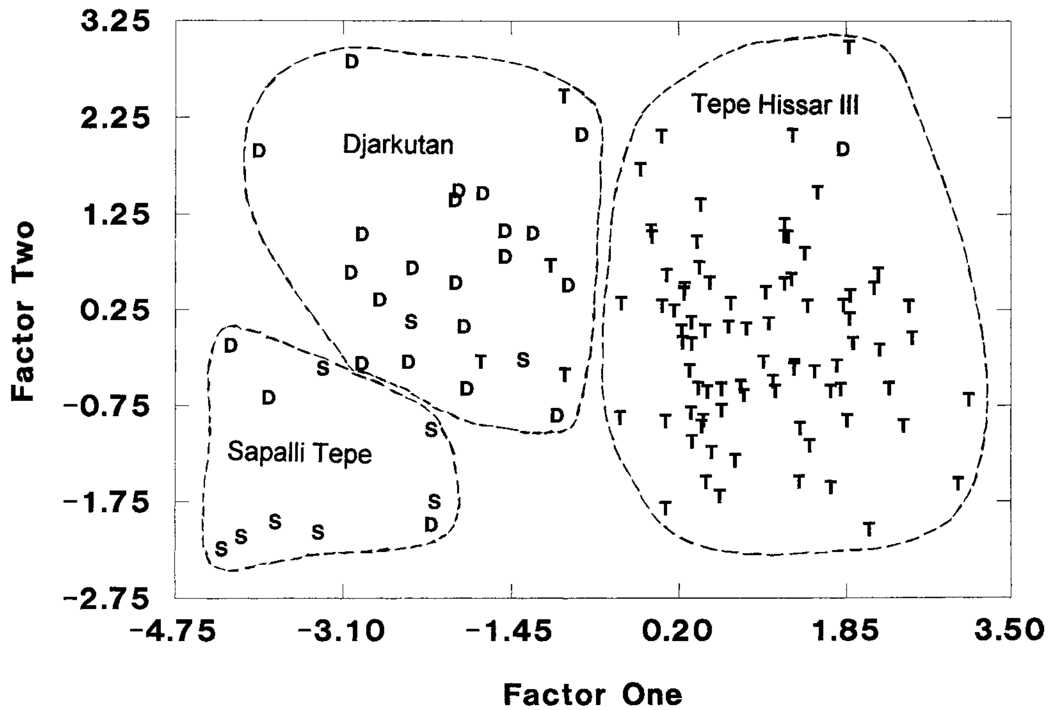

Fig. 3. Plot of individual discriminant function scores without anomalous burials.

TABLE 7. Discriminant function classification of individuals across all three samples

Actual sample	Predicted sample: Djarkutan	Sapalli Tepe	Tepe Hissar III	Individuals correctly assigned: *n*	Percent
Djarkutan	19	4	1	19/24	79.2
Sapalli Tepe	2	7	0	7/9	77.8
Tepe Hissar III	4	0	81	81/85	95.3
TOTAL	25	11	82	107/118	90.7

TABLE 8. Discriminant function classification of individuals Central Asians vs. Tepe Hissar III

Actual sample	Predicted sample: Central Asia	Tepe Hissar III	Individuals correctly assigned: *n*	Percent
Central Asia	32	1	32/33	97.0
Tepe Hissar III	4	81	81/85	95.3
TOTAL	36	82	113/118	95.8

TABLE 9. Bootstrap examination of correct individual classification

	Across all three samples (%)	Central Asians vs. Tepe Hissar III (%)
Apparent correct classification	90.7	95.8
Bootstrap correct classification	78.7	88.6
0.632 estimator classification	83.1	91.3

provides little evidence to support the hypothesis that these individuals represent foreign elites from the urban centers of the Oxus civilization. Only one (A_5) of these individuals exhibits closest affinities to central Asians from the north Bactrian oasis. The majority appear little differentiated from other males recovered from the Period III necropolis at Tepe Hissar.

When the results of this analysis are considered in light of the two major hypotheses currently offered to explain the nature

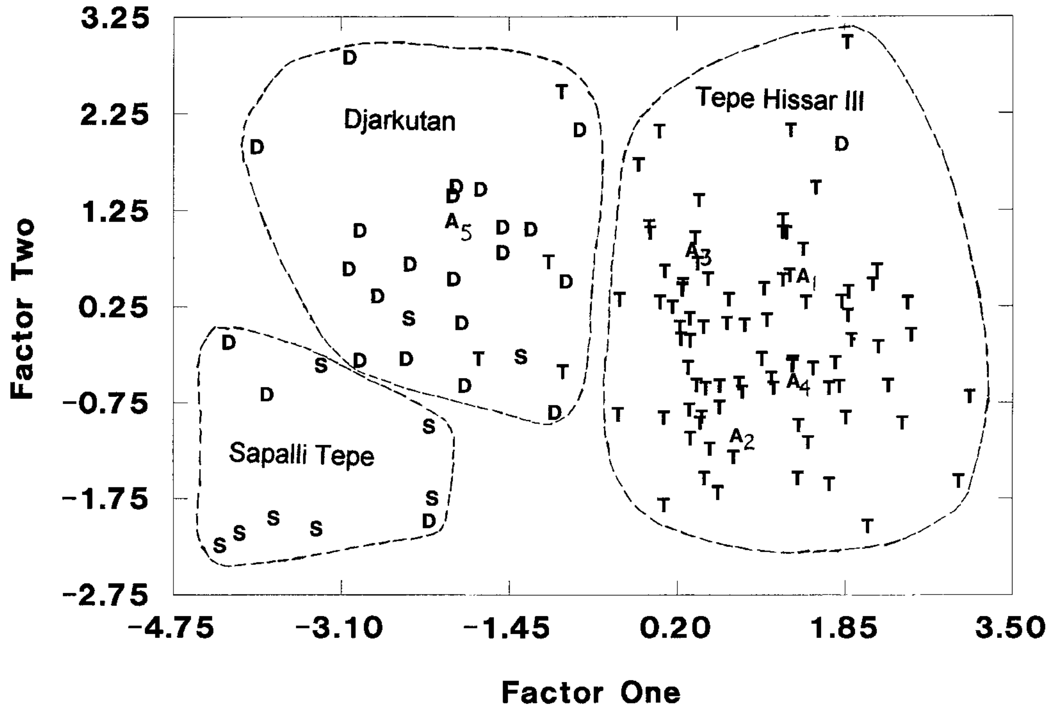

Fig. 4. Plot of individual discriminant function scores with anomalous burials.

of interaction between Oxus civilization populations with those of neighboring regions, there appears to be little support for the argument that the Oxus civilization represented a hegemonistic power within the Indo-Iranian borderlands that expanded throughout this vast region by imposing a coterie of foreign elites within neighboring urban centers (Hiebert, 1994; Hiebert and Lamberg-Karlovsky, 1992; Lamberg-Karlovsky, 1993, 1994b; Sarianidi, 1993, 1994). The results obtained are in greater accord with the assertion that Oxus civilization populations were but one of many groups across the Indo-Iranian borderlands, whose elites participated in a bidirectional exchange network (Amiet, 1988; Jarrige, 1994; Tosi, 1988).

Taken at face value, the results of this analysis would appear clear. There is no evidence to suggest the presence of an imposed foreign elite of central Asians at Tepe Hissar. Rather, these individuals appear to have been local elites genetically similar to other Period III Tepe Hissar individuals not associated with these unusual artifacts. However, several important caveats must be contemplated before one hypothesis is conclusively rejected and the other accepted.

The first is that only a small minority (5/30) of those identified by Schmidt (1933, 1937) as Period III individuals associated with anomalous artifacts are available for comparison. Additional analysis of the rest of these individuals (currently curated in Teheran) may yield different results.

Second, by limiting the analysis to males, the contrast between Oxus civilization samples from central Asia and Period III individuals from Tepe Hissar is severely constrained. In fact, both males and females from the Period III necropolis were identified in direct association with anomalous artifacts. Although proponents of the foreign elite dominance hypothesis often couch the nature of this interaction in such militaristic terms as "conquest" (Hiebert, 1994; Lamberg-Karlovsky, 1994b), it is equally likely that central Asian control could have been established by other means (see Hiebert, 1998).

One possibility is that the Oxus civilization may have extended its influence throughout the Indo-Iranian borderlands by means of strategic marital alliances. Such alliances may have involved the relocation of Oxus civilization females to the urban centers of their Indo-Iranian spouses. Until the remaining Period III females from Tepe Hissar associated with anomalous artifacts become available for study, this possibility must remain an untested but plausible hypothesis.

Third, until recently most scholars concluded that the Oxus civilization populations of the north Bactrian oasis were the product of a wholesale colonization event from urban centers of the Kopet Dagh foothill plain, first to the Margiana oasis of eastern Turkmenistan, and then to Bactria (Biscione, 1977; Masson, 1981; Masson and Sarianidi, 1972; Askarov, 1977, 1981; Hiebert, 1994; Hiebert and Lamberg-Karlovsky, 1992; Lamberg-Karlovsky, 1994b). This view is beginning to be questioned.

Evidence from Sapalli tepe indicates that the Oxus civilization appears as early in the north Bactrian oasis as in Margiana (Hiebert, personal communication) and recent craniometric studies of phenetic affinities among Bronze Age central Asians (Hemphill, 1998, 1999) found little evidence that north Bactrian populations were the product of wholesale colonization from Kopet Dagh urban centers to the west. Such evidence refutes the previously held assumption that Marginan and Bactrian Oxus civilization populations were biologically homogeneous. This absence of genetic homogeneity provides the basis for the possibility that contacts, whether through foreign elite dominance or bidirectional trade and genetic exchange, between the Oxus civilization and Tepe Hissar, may have occurred with the geographically more proximate populations of Margiana. Unfortunately, while skeletal remains of Oxus civilization populations of Margiana are known, none have been analyzed by physical anthropologists. Hence, the possible lack of homogeneity between Marginan and Bactrian populations and a possible sphere of interaction between these Marginan populations and the Period III inhabitants of Tepe Hissar remains untested.

Finally, previous craniometric comparisons (Hemphill, 1998, 1999) between north Bactrian Oxus civilization and Iranian samples indicate that whatever phenetic rapprochement occurs between these two populations arises near the very end of the Terminal Late Bronze Age. These comparisons document a slight phenetic convergence between the Molali phase (1650–1500 BC) inhabitants of the north Bactrian oasis and Period III individuals from Tepe Hissar. Thus, it may be that the cultural expansion involving Oxus civilization populations and neighboring regions did not take place until the later phases of this civilization. A contrast between Oxus civilization samples and Period III individuals from Tepe Hissar that encompasses Oxus civilization samples from earlier phases may obscure phenetic identification of these Period III individuals from Tepe Hissar associated with anomalous artifacts. Until additional excavations are conducted at Djarkutan and provide such a comparison, this possibility must also remain open.

CONCLUSIONS

The results of this analysis provide a strong separation between central Asian Oxus civilization males from the north Bactrian oasis and Period III males from Tepe Hissar. It is unlikely that this phenetic separation is the product of differential masticatory stress, adaptation to markedly different environments, or interobserver error. Canonical discriminant function analysis indicates that four of the five males recovered from the Period III necropolis at Tepe Hissar associated with anomalous artifacts exhibit closest phenetic affinities to other Tepe Hissar Period III males. Taken at face value, these results provide no evidence that these individuals represent an imposed foreign elite from central Asia. Rather, these results suggest that such individuals are best explained as local elites who participated in a non-hegemonistic inter-regional exchange network of high-status prestige items. Nevertheless, these conclusions must remain tentative in light of unanalyzed Period III remains curated in Teheran, lack of crucial

female specimens, questions concerning the biological homogeneity of Oxus civilization populations from the oases of Margiana and Bactria, and the lack of sufficient comparative skeletal samples from later phases of the Oxus civilization.

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